

Chapter 1

Introduction

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The Wyoming State Engineer's Office (SEO) published the first State Framework Water Plan in 1973 under the Wyoming Water Planning Program. The publication presented a water resources plan for the entire state of Wyoming and included summary water plans for each of the state's seven major river drainages. In 1975, the Wyoming Legislature established the Wyoming Water Development Commission (WWDC) and Wyoming Water Development Office (WWDO) to coordinate planning, development, and project management efforts for water and related land resources. Between 1979 and 1995, the WWDO completed several major river basin planning studies.

The development of the present State Water Planning Process began in 1997 when the state legislature directed WWDC to conduct a feasibility study, in collaboration with the University of Wyoming (UW) and the SEO, which included public input and compilation of a statewide water inventory. Based on the feasibility study, the Wyoming Legislature accepted the recommended planning framework to update the original 1973 State Framework Water Plan and funded the State Water Planning Process in 1999, specifically to:

- inventory the state's water resources and related lands,
 - summarize the state's present water uses and project future water needs,
 - identify alternatives to meet projected future water needs, and
 - direct water resource planning for the state of Wyoming for a 30-year timeframe.
- The Wyoming Framework Water Plan (WWC Engineering and others, 2007) summarized the separate water plans for Wyoming's seven major river basins (**fig. 1-1**) completed between 2001 and 2006.

Technical Memorandum S of the previous Snake/Salt River Basin Water Plan (Sunrise Engineering and others, 2003) contains a groundwater resource investigation that thoroughly examines the basin's resources and usage. This Available Groundwater Determination represents the most current assessment of the groundwater resources in the Snake/

Salt River Basin, updating and expanding the information presented in the 2003 groundwater investigation. The data contained in this memorandum are a compilation of existing information obtained by several state and federal agencies. While original maps and tables were developed, and existing maps and tables were updated and modified, no original research was conducted for this memorandum.

The format of this update follows the general layout of other, recent groundwater determinations co-authored by the Wyoming State Geological Survey (WSGS) and U.S. Geological Survey (USGS) for the Green River Basin (2010), the Wind/Bighorn River Basin (2012), the Platte River Basin (2013), and the Bear River Basin (2014); this memorandum incorporates much of the content of these four previous studies, frequently without citation.

1.1 Interagency Agreement and scope

The WWDC and WSGS entered into an Interagency Agreement in September 2011 to update the groundwater information contained in the previous Snake/Salt River Basin water plan (Sunrise Engineering and others, 2003). The previous Snake/Salt River Water Plan is available on the WWDC website at <http://waterplan.state.wy.us/plan/snake/snake-plan.html>. The agreement outlined the following tasks to update the previous Snake/Salt River Basin water plans:

- **Identify the major (i.e., most widely used) aquifers in the Snake/Salt River Basin:**
To make this determination, the USGS defined all aquifers and confining units in the Snake/Salt River Basin and presented the information on hydrostratigraphic nomenclature charts (**pIs. 4, 5, and 6**). Based on these detailed analyses, the Geographic Information System (GIS) geologic units mapped on **plate 1** and described in **appendix A** were organized into a comprehensive hydrostratigraphic chart and surface hydrogeology map for the Snake/Salt River Basin (**pl. 2**). In some cases, two or more minor aquifers that are hydrologically connected are grouped and treated as a single combined hydrogeologic unit. The general

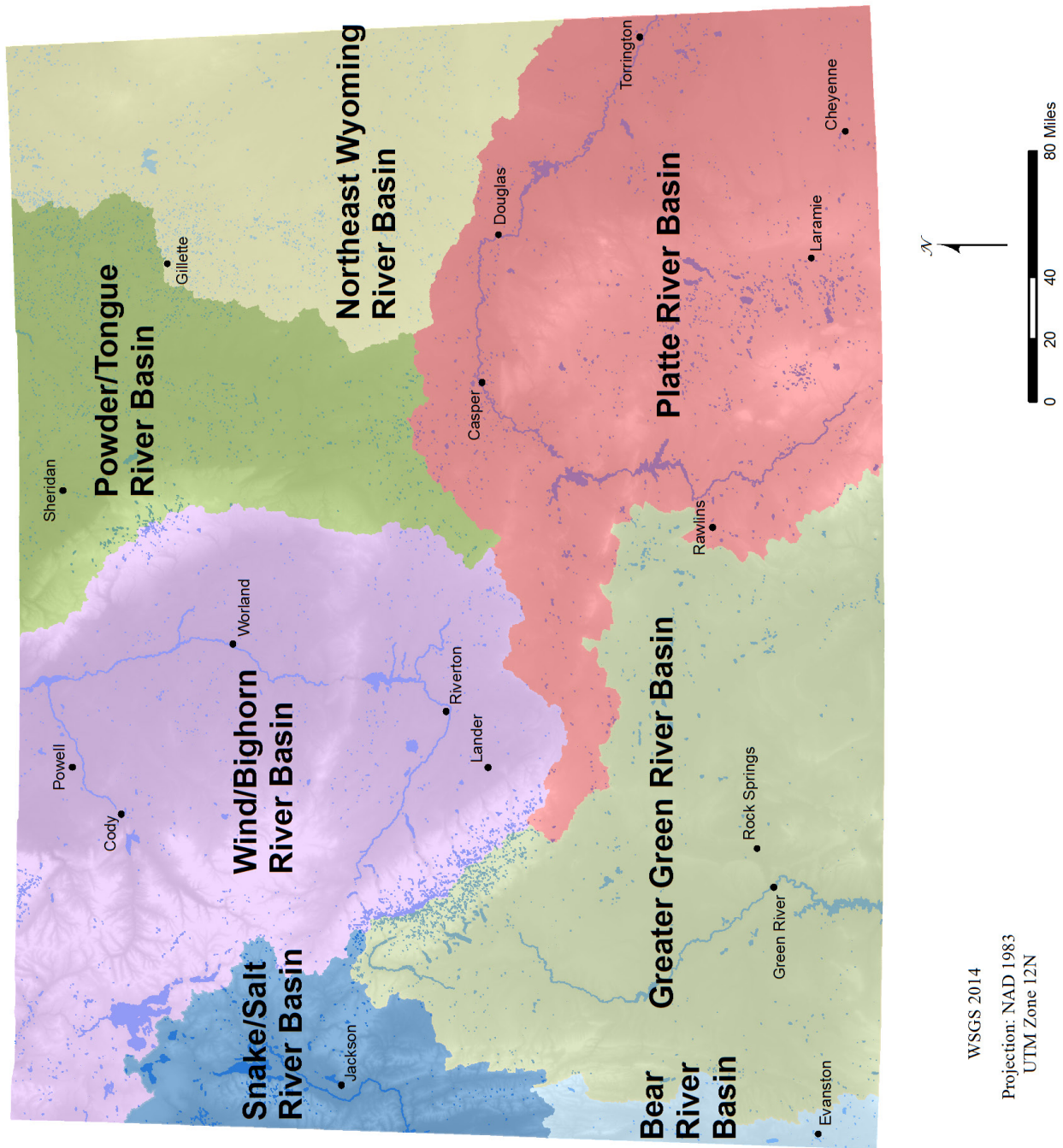


Figure 1-1. Major drainage basins, Wyoming.

geology of the Snake/Salt River Basin is discussed in **chapter 4** and individual aquifers are detailed in **chapter 7**.

- **Define the three-dimensional extent of the aquifers:**
Plate 2 is a map of the outcrop areas for the Snake/Salt River Basin's aquifers and confining units. Six cross sections (**figs. 4-2** through **4-7**) illustrate the subsurface configuration of the geologic units that constitute the hydrogeologic units at selected locales within the basin. Isopach maps with substantial coverage of the major aquifers in the Snake/Salt River Basin are not available at this time.
- **Describe the following hydraulic, hydrogeologic, and hydrogeochemical properties of the aquifers and confining units:**
 - Physical characteristics – **chapters 4** and **7** discuss the lithologic and hydrogeologic characteristics of the hydrogeologic units identified in **plate 2**.
 - Water chemistry with comparisons to applicable state and federal regulatory standards by class of use – **chapters 5** and **7** contain extensive discussions of basin water quality with comparisons to regulatory standards. Statistical analyses of water chemistry are presented in **appendices E** and **F**.
 - Principal potential pollutants - **chapter 5** contains a discussion of potential pollution sources. Maps of these facilities are provided in **figures 5-4** through **5-10**.
- **Estimate the quantity of water in the aquifers:**
Data sufficient for a basinwide, aquifer-specific assessment of groundwater quantity is not available. The complex geology of the Snake/Salt River Basin does not lend itself to the general assumptions about aquifer properties, geometry, and saturated thickness that a plausible estimate of total and producible groundwater resources requires. The most important aquifers in the Snake/Salt River Basin, includ-

ing the Snake/Salt River Alluvium and the Salt Lake, Teewinot, and Wind River formations, have been described in numerous, specific studies (**appendix B**) that are more comprehensive and relevant than a summary estimate. Groundwater resource estimates are addressed in this technical memorandum by analysis of recharge (**chapter 6**) and a basin-wide water balance (**chapter 8**).

- **Describe the aquifer recharge areas:**
Plate 2 is a map of the outcrop areas of aquifers and confining units in the Snake/Salt River Basin. Maps depicting the outcrop areas used to calculate the annual rate of recharge for specific aquifers and groups of aquifers throughout the Snake/Salt River Basin are provided in **figures 6-1 – 6-6**. **Section 5.1** and **chapter 6** discuss recharge.
- **Estimate aquifer recharge rates:**
Existing maps depicting average annual precipitation (**fig. 3-3**) and estimated recharge rates (**fig. 5-2**) over the entire Snake/Salt River Basin were adapted for presentation in this technical memorandum. Existing annual recharge rates were multiplied by aquifer outcrop areas (**figs. 6-1** through **6-6**) to estimate a range of annual recharge volumes for individual and combined aquifers. The results of these estimates are summarized in **tables 6-1** through **6-3** and discussed in **section 6-2**. **Figure 6-7** represents recharge as a percentage of precipitation and **section 6-2** describes how recharge efficiency varies by individual and combined aquifers overall within the Snake/Salt River Basin.
- **Estimate the “safe yield” potential for the aquifers and describe implications of hydrologically connected groundwater and surface water:**
The concept of “safe yield” is discussed in **section 5.1.4**. This report provides estimates of total recharge (average annual) for the Snake/Salt River Basin in **chapter 6** and compares these recharge estimates to current groundwater withdrawals in **chapter 8**.

- **Describe and evaluate existing groundwater studies and models:**

Existing groundwater models are identified and evaluated, and recommendations for future groundwater modeling in the Snake/Salt River Basin are discussed in **chapter 7**.

- **Identify future groundwater development opportunities to satisfy projected agricultural, municipal, and industrial demands:**

Several approaches to address future groundwater development potential are discussed throughout this report.

- General and aquifer-specific hydrogeology relative to groundwater development potential is discussed in **chapters 5 and 7**.
- **Figures 8-1 through 8-7** show wells permitted by the SEO in the Snake/Salt River Basin through February 27, 2012. These figures include selected groundwater permit statistics and illustrate historic groundwater development patterns relative to sub-region, hydrogeologic unit outcrop patterns. SEO permits issued for the period from January 1, 2003 through February 27, 2012, shown on inset tables contained within these figures, illustrate the focus of recent groundwater development efforts. Existing groundwater development in the Snake/Salt River Basin is discussed in **chapters 7 and 8**.
- A summary of groundwater development studies and projects in the Snake/Salt River Basin, sponsored by the WWDC, is included in **appendix B**. The development potential of specific aquifers, based on information compiled from these and other studies, is described in **chapter 7**.
- Groundwater development prospects identified in the groundwater resource investigations of the previous Snake/Salt River Basin Water Plan (Sunrise Engineering and others, 2003) are discussed in **chapter 9**.
- Current WWDC and SEO projects related to groundwater development in the Snake/Salt River Basin are discussed in **chapter 9**.

1.2 Agency participation

This technical memorandum is the result of a co-operative effort by the WWDC/WWDO, WSGS, USGS, and the Water Resources Data System (WRDS). The SEO and the Wyoming Department of Environmental Quality (WDEQ) contributed significant datasets for developing some of the figures presented in this technical memorandum.

- The WWDO and WRDS provided the WSGS with overall program guidance and standards, software, and format requirements for deliverables (e.g., maps, databases, metadata, tables, and graphs).
- WSGS was the primary compiler of the information developed in **chapters 1 through 6 and chapters 8, and 9**.
- The USGS, under contract to the WSGS, compiled the information used in **chapter 7 and section 5.6.1**.
- The WSGS and USGS cooperated on sections of **chapters 5 and 9**.
- On behalf of WWDC/WWDO, the WRDS will feature the associated deliverables on its website at <http://www.wrds.uwyo.edu/>.

The WWDC, the water development and water planning agency for Wyoming, administers publicly funded development, construction, rehabilitation, and related water projects through its professional and support staff at the WWDO.

The WSGS is a separate operating agency under the executive branch of state government (Wyoming State Statutes 9-2-801 and 9-2-803 through 9-2-810). The WSGS's purposes are 1) to study, examine, and understand the geology, mineral resources, and physical features of the state; 2) to prepare, publish, and distribute (free or for a nominal price) reports and maps of the state's geology, mineral resources, and physical features; and 3) to provide information, advice, and services related to the geology, mineral resources, and physical features of the state. The survey's mission is to "promote the beneficial and environmentally sound use of Wyoming's vast geologic, mineral, and energy

resources, while helping protect the public from geologic hazards.” By providing accurate information and expanding knowledge through the application of geologic principles, the WSGS contributes to the economic growth of the state. WSGS hydrogeologists conduct research; compile data; create and distribute maps and reports; and address inquiries to assist citizens, industry, and state and federal agencies in planning, decision making, and analysis of water issues.

The USGS provides data, maps, reports, and other scientific information to help individuals and local and state governments manage, develop, and protect the United States’ water, energy, mineral, and land resources. The agency’s mission is to “provide reliable scientific information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.” Toward these goals, the USGS employs experienced scientists and support staff from a wide range of disciplines.

The WRDS is a clearinghouse for hydrological data. The WRDS is funded by the WWDO to provide a variety of services, including the online provision of groundwater resources information, maps, and publications.

The SEO and WWDO cooperate on many projects. SEO personnel attend meetings on river basin planning and other WWDC projects. WWDC-funded groundwater development projects generally require permits from both the SEO and WDEQ (K. Clarey, WWDO, personal communication).

1.3 Legal and institutional framework

Wyoming laws that govern the appropriation, development, and beneficial use of water resources are based on the doctrine of prior appropriation, commonly stated as “*first in time is first in right*.” This means that, during periods of limited supply, the first party to put a source of water to beneficial use has a “priority” water-right honored prior to those of other, later users. An exception is that municipalities can obtain water-rights from earlier priority uses through eminent domain (Wyoming

State Statutes 1-26). The Wyoming Constitution establishes that all natural waters are property of the state. Therefore, a water-right does not grant ownership, but only the right to use water for beneficial purposes. Use of water resources for domestic and livestock purposes customarily takes precedence over other uses. In Wyoming, water-rights are attached to the land and can be transferred. The laws and regulations pertaining to the appropriation, development, and beneficial use of groundwater are administered by the SEO and Board of Control, a panel comprised of the superintendents of the four state water divisions and the state engineer. The entire Snake/Salt River Basin area is included in SEO Water Division IV. A comprehensive discussion of the laws that govern Wyoming water resources is provided online at: <http://seo.state.wy.us/PDF/b849r.pdf>.

1.3.1 Wyoming water law – groundwater appropriation, development, and use

Groundwater within the state is owned and controlled by the state of Wyoming. Under Wyoming law, groundwater includes any water (including geothermal waters) under the land surface or under the bed of any body of surface water. The SEO is responsible for the permitting and orderly development of groundwater in Wyoming and for protecting groundwater resources from waste and contamination. The updated Wind/Bighorn River Basin Water Plan (MWH and others, 2010) provides the following discussion of Wyoming water law specific to groundwater:

“Wyoming’s groundwater laws were originally enacted in 1945 and amended in 1947. These laws were replaced by new groundwater laws on March 1, 1958, which were then amended in 1969. Groundwater is administered on a permit basis. The acquisition of groundwater rights generally follows the same permitting procedures as surface water rights, except that a map is not required at the time of permit application. Applications are submitted to and approved by the WSEO [sic] prior to drilling a well. With the completion of the well and application of the water to a beneficial use, the

appropriation can then be adjudicated. The issuance of well permits carries no guarantee of a continued water level or artesian pressure.” “As with surface water rights, groundwater rights are administered on a priority basis. For all wells drilled prior to April 1, 1947, a statement of claim process was followed to determine the priority date of the well. For wells drilled between April 1, 1947 and March 1, 1958, the priority date is the date the well was registered. For wells drilled after March 1, 1958, the priority date is the date the application was received at the WSEO [sic].”

“Domestic and stock wells are those wells used for non-commercial household use, including lawn and garden watering that does not exceed one acre in aerial extent, and the watering of stock. The yield from these wells cannot exceed 25 gallons per minute (gpm). Prior to the 1969 amendment, domestic and stock wells were exempt from the requirement to obtain a permit and held a preferred right over other wells. The 1969 amendment established priorities for domestic and stock wells similar to those for other wells. The Groundwater Division [of the SEO] also issues permits for spring developments where the total yield or flow of the spring is 25 gpm or less and where the proposed use is for stock and/or domestic purposes.”

1.3.2 Interstate agreements

Surface water resources of Wyoming are subject to interstate agreements that limit how much streamflow can be depleted before leaving the state. Furthermore, conflicts among users within the state or across state lines can occur where groundwater extraction may affect surface flows. Although interconnection between groundwater and surface water is not currently a significant water-rights issue in the Snake/Salt River Basin, it could become a point of contention in the future as the basin’s population grows.

To avert conflicts over the allocation and use of surface water flows within the Snake/Salt River Basin, the states of Idaho and Wyoming agreed to

the Snake River Compact in 1949. The Compact allocates 4 percent of the waters of the Snake River to Wyoming and 96 percent to Idaho exclusive of established Wyoming water rights (prior to the date of signing) for direct diversion or storage. Unlike the Bear and Platte River Basins, the Compact considers surface flows only and does not place any regulation on the allocation and development of groundwater. The Snake River Compact is available for review at: <https://sites.google.com/a/wyo.gov/seo/interstate-streams>.

The basin area, examined in this report, consists of the Wyoming portion of the Snake and Salt River Basins and tributary areas in Idaho and Yellowstone National Park (**fig. 3-1**).

1.3.3 Wyoming water law – groundwater quality

The Denver office of the U.S. Environmental Protection Agency (EPA) Region 8 has primary control (primacy) over Wyoming’s public drinking water supplies. Wyoming is the only state in which EPA has primacy over drinking water systems. The EPA monitors water quality for the several hundred public water systems in Wyoming. Information about Wyoming’s public drinking water systems is available on the EPA Wyoming Drinking Water website:

<http://www.epa.gov/safewater/dwinfo/wy.html>

Except on the Wind River Indian Reservation, the WDEQ enforces groundwater quality regulations under the Wyoming Environmental Quality Act, with guidance from the Wyoming Environmental Quality Council. The WDEQ administers provisions of the federal Clean Water Act Amendment of 1972 (Section 208) that provide for water quality management by state and local governments, as well as provisions of the Federal Water Pollution Act, by developing a State Water Quality Plan approved by the EPA. In general, operations under the jurisdiction of the Wyoming Oil and Gas Conservation Commission (WOGCC), U.S. Bureau of Land Management (BLM), EPA, or U.S. Forest Service that cause groundwater contamination are referred to the WDEQ. The WOGCC has jurisdiction over Class II underground injection

wells (**chapter 5**) dedicated to disposal of produced water from state and federal oil and gas leases.

I.3.4 Other agencies

The U.S. Bureau of Reclamation (BOR), an agency under the U.S. Department of the Interior, oversees and manages water resources specifically related to the operation of numerous water diversions, delivery, storage, and hydroelectric power generation projects built by the federal government throughout the western United States. The BOR cooperates with the SEO and the WWDC but as a federal agency has autonomy to execute some programs unilaterally. The BOR coordinates releases from Wyoming's reservoirs with the SEO. (K. Clary, WWDO, personal communication). Although not a primary area of concern, the BOR and the following other agencies are occasionally involved in groundwater resource issues:

- Wyoming Department of Agriculture
- U.S. Department of Agriculture
- U.S. National Park Service
- U.S. Army Corps of Engineers
- U.S. National Resources Conservation Service
- U.S. Office of Surface Mining, Reclamation and Enforcement
- U.S. Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement
- U.S. Department of Energy
- U.S. Nuclear Regulatory Commission

I.4 Authorship

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